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2. Father Ryan offered some suggestions in regard to the present day status of mathematics in the high schools, which led up to a discussion of measures that should be taken to promote intensive work in mathematics.

3. In this paper Professor Roever first stated the criteria which must be satisfied by a drawing (on a plane or curved surface) in order that it should be an adequate and good looking representation of a space object. He then showed, as a consequence of these criteria, that a drawing must be a central or parallel (orthographic or oblique) projection of the space object to be represented, and gave the conditions under which one or two projections are required in order adequately to represent the object. Finally, rules of procedure were developed and exemplified.

4. Professor Hedrick called the attention of the Section to the organization of a joint committee under the auspices of the Society for the Promotion of Engineering Education and the Mathematical Association of America. He pointed out the close relationship between mathematics and engineering, and mentioned briefly both the history of previous investigations of mathematical teaching in schools of engineering and the plans of the present committee.

5. Professors Hedrick and Roever called attention to a recent paper (R. von Huhn, "A new graphic analytic method," *Science*, October 7, 1921) and pointed out that it is a very special case of the general method given by Professor Roever in this MONTHLY, *1916*, 330–333. They also showed how the method could be used in more general problems, including the elimination of one variable from two equations in three variables. [Published in *Science*, April 14, 1922.]

6. In this paper Professor Rietz showed by concrete illustrations the character of the statistical problems to which the theorem of Bernoulli is applicable, and presented an elementary demonstration of the theorem for the purpose of giving a clear view of a method of treatment of a fundamental problem in the fluctuations of results derived from random samples. [Published in *Mathematics Teacher*, December, 1921.]

7. The paper of Dr. Weeks, who is a member of the National Committee on Mathematical Requirements, gave a brief outline of the contents of the final report of the committee, with statements about the publication and distribution of this report.

PAUL R. RIDER, *Secretary-Treasurer.*

THE NOVEMBER MEETING OF THE TEXAS SECTION.

The first regular meeting of the Texas Section was held at the Bryan High School, Dallas, Texas, on November 25–26, in conjunction with a meeting of the Mathematics Section of the Texas State Teachers' Association. Three meetings were held. G. C. EVANS presided at the session of Friday morning, H. J. ETTLINGER, president of the Mathematics Section of the Texas State Teachers' Association, at the session of Friday afternoon, and J. O. MAHONEY at the closing session of Saturday morning.

One of the very enjoyable features of the occasion was the banquet for the members of the Texas Section of the Association held in the Violet Room of the Oriental Hotel. President Ettlinger presided as toastmaster.

There were sixty-five in attendance, including the following eighteen members of the Association:

W. D. Baten, H. Y. Benedict, A. A. Bennett, J. E. Burnam, P. J. Daniell, H. J. Ettlinger, G. C. Evans, L. R. Ford, A. J. Hargett, H. Hosford, E. H. Jones, J. O. Mahoney, R. L. Moore, H. Porter, J. L. Riley, P. C. Rockwell, E. R. Tucker, P. H. Underwood, N. Wunder.

The following officers were elected for the coming year: Chairman, G. C. EVANS; Vice-Chairman, A. A. BENNETT; Secretary-Treasurer, W. D. BATEN. The next meeting will be held at Houston, December 1–2, 1922, in conjunction with the annual meeting of the Mathematics Section of the Texas State Teachers' Association.

The following papers were read:

(1) "Dante and science" by Professor G. C. EVANS;

(2) "What the college or university expects of the freshman in the way of mathematics" by Professor H. J. ETTLINGER;

(3) "An actuary: his training, functions and service" by C. P. ROCKWELL;

(4) "The rôle of logic in the refinement of geometric intuition" by Professor R. L. MOORE;

(5) "What the state section of the Mathematical Association of America can do for mathematics in Texas" by Professor J. L. RILEY;

(6) "On teaching the fractional exponent" by Professor W. D. BATEN;

(7) "The number system of algebra" by Professor A. A. BENNETT.

Abstracts of most of the papers and discussions follow below, the numbers corresponding to numbers in the list of titles.

1. Professor Evans gave a résumé of his paper as published in *The Rice Institute Pamphlet,* volume 8, April, 1921, on the occasion of the Dante Sexcentenary. Before his exile Dante had demonstrated his extraordinary ability and his interest in both poetry and science. No reader can follow adequately a work like the *Divine Comedy* without some knowledge of the mechanical frame on which it is consciously built, and some understanding of the physical aspect of the mediæval universe. For here Dante himself was an expert. The astronomy of Dante's time, which occupied a secondary place to that of astrology, was merely the astronomy of Hipparchus. Interpreted in the light of modern knowledge it was an approximate representation of apparent angular motions of the stars and planets as seen from the earth, by means of a system of uniformly moving epicycles and eccentrics. It was thus an attempt to build up the variable apparent motions of the heavens out of a system of uniform circular motions about centers themselves also moving uniformly.

Knowing well the phenomena of the precession of the equinoxes discovered by Hipparchus, Dante was enabled to proceed accurately on his voyage of the heavens. According to Dante the earth occupies a central position at rest and the orbits of the moon, planets, sun, and stars are fixed on concentric spheres, or heavens of various radii.

The mediæval, or Dantean, order of the spheres is this: (1) Moon, (2) Mercury, (3) Venus, (4) Sun, (5) Mars, (6) Jupiter, (7) Saturn, (8) Stars, (9) Crystalline or Primum Mobile, (10) the Empyrean Heaven.

2. Professor Ettlinger gave the conclusions drawn from the answers to a questionnaire concerning the knowledge of mathematics required in other departments of the University of Texas of students who are taking or have completed the work of the freshman year. Opinions were solicited from each department relative to the value of each topic listed. The plan of the questionnaire followed the fourth section of that issued by the National Committee on Mathematical Requirements. This paper will be published in the *Texas Mathematics Teachers' Bulletin.*

3. Mr. Rockwell, in the course of his remarks, said: "Mathematical training, with patient study and practice, may make a perfect mathematician, but still fail to give us an actuary. To the born mathematical genius, or to the person with acquired mathematical talent, must be added something that is absolutely essential to produce the actuary. That something includes a minute observation of the practical workings of life insurance, the ability to recognize and appreciate the weight and importance of business interests and business requirements."

Recent features of insurance practically new to American life, as group insurance, industrial insurance and annuities, have increased the responsibilities of the actuary. The generally accepted notion that the sole duty of the actuary is to furnish tables in keeping with the "policies" by the company agents has been dispelled. The actuary must be in close coöperation with the medical director so as to pass upon certain risks and with the general directors to advise on certain financial risks and policies.

4. Professor Moore spoke of the rôle of logic in the treatment of propositions in elementary geometry. The demonstration of some well-known elementary propositions led to rather fanciful results, or fallacies, when demonstrated without regard to logical sequence. The age-old problem of whether or not strictly logical treatment must be required was discussed.

6. Professor Baten spoke of the troubles that beset first year students when they take up the work of exponents in college algebra. He emphasized the very close relation existing between the study of exponents, the study of logarithms and the subject of radicals. The fact that the average freshman did not know that the value of $a^0 = 1$ was reasserted.

7. In this paper, Professor Bennett discussed the development of the number system of algebra through its principal historical and logical steps. He contrasted the usual method of elementary arithmetic, wherein the discussion of fractions precedes that of negative numbers, with the procedure in algebraic treatments, where this sequence is usually reversed, and spoke of the justification of each line of development. The principal feature of the paper was an analysis of the postulates of algebra into three groups, the first treating of rational operations

alone, the second, of order relations alone, the third, of order relations among the results of rational operations. This classification corresponds intimately to the characterizations of the theorems of algebra as falling into three analogous categories.

J. L. Riley, *Secretary-Treasurer.*

CUSPIDAL ENVELOPE ROSETTES.

By William F. Rigge, Creighton University.

A point P moves in the line segment EG, Fig. 1, with simple harmonic motion of p cycles, while this segment makes q revolutions about A with uniform angular speed. Moritz[1] has exhaustively treated the case when the point A is in the line EG or in its prolongation. The writer[2] has shown that when the point A is out of the line EG and the rosette drawn is cuspidal, AL, the distance of EG from A, must be $n \sin \beta$ (in which $n = p/q$) and LR, the distance of R, the mid-point, or point of zero phase, of EG, from its point of tangency L on the *tangent* circle, must be $\cos \beta$. The point P remains on an ellipse whose conjugate semi-axis is unity ($= ER = RG$) and is always parallel to EG, whose major semi-axis $= n$, and whose center is the sine PR of the phase α distant from A, β being the eccentric angle of P.

When the point P is given a double rectilinear harmonic motion[3] with equal amplitudes but with periods in the ratio of m to 1, it may be conceived to move with simple harmonic motion of mn periods on the line segment DF, Fig. 2, while this line slides n times in a similar way along the line EG in one revolution of EG about A. For the sake of greater clearness these lines DF and EG are spaced a short distance apart in the figure. PS is then the sine of the phase of P on DF, while RS is the sine of the phase of S, the mid-point of DF, on EG. Hence the distance of the tracing point P from the *tangent* circle measured along the tangent line $GFED$ is

$$LP = -RL + RS + SP = -\cos \beta + \sin n\theta + \sin mn\theta,$$

in which θ is the phase of the circular motion about A. In the previous paper the point A was in the line EG. In the present A will be out of this line. The discussion will, as before, be confined to envelopes that are cuspidal.

Two Envelopes. As the points D and F are the limits of the excursions of P on this line segment DF, it is clear that these points themselves would trace the envelopes to all the lobes or loops or branches drawn by P, and that P must be on these envelopes when it is in phases 90° and 270°, respectively, on DF. The

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[1] "On the construction of certain curves in polar coördinates" by R. E. Moritz, in this Monthly, *1917*, 213–220.

[2] "Concerning a new method of tracing cardioids" by W. F. Rigge, in this Monthly, *1919*, 21–32. "Cuspidal rosettes," in this Monthly, *1919*, 332–340.

[3] "Envelope Rosettes," in this Monthly, *1920*, 151–157.